Impact of Agricultural Production on Economic Growth in Zimbabwe

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To achieve inclusive growth, and poverty and inequality reduction, African countries should enhance labour-intensive agricultural production due to their abundance of natural resources and labour. In this paper, we examine the impact of agriculture on the economic growth of Zimbabwe using the Autoregressive Distributed Lag (ARDL) model employing data covering the period 1970 to 2019. The results show that agricultural production has a significant positive impact on economic growth in the short run while showing no impact on economic growth in the long run. Additionally, the study confirms that inflation, government expenditure and gross fixed capital formation have a positive impact on economic growth in both the long run and short run. Although the agricultural sector plays a salient role in the early stages of economic development, it is, however, not able to maintain sustainable economic growth over a long period in Zimbabwe. Additional macro-economic policy levers are required to compliment agricultural production and promote sustainable economic growth.

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Introduction

To recover the lost progress on their objective of achieving of inclusive growth, sub-Saharan African countries must strengthen the production of labour-intensive agricultural products. There is well-documented research supporting the viewpoint that agriculture production stimulates economic growth, and if this is indeed the case, African economies can specialise in agricultural production as a solution to end poverty and food insecurities. The abundance of various kinds of natural and human resources in African economies, including Zimbabwe, gives the countries an upper hand to strengthen their comparative advantage in agricultural products if these resources are used efficiently and effectively. With the promotion and expansion of intra-regional trade, developing countries like Zimbabwe may reap benefits from trading agricultural smart goods with other countries within Africa, thereby recovering the lost progress on sustainable development caused by the outbreak of the COVID-19 pandemic and previous political or economic shocks.

Zimbabwe has been facing pressing economic challenges for the past two decades and this has been aggravated by the COVID-19 pandemic. Like other developing African economies, Zimbabwe's economy is characterised by extreme poverty, high inequalities and hyperinflation. The World Bank (The World Bank Group 2022b) shows that the extreme poverty rate in Zimbabwe increased steadily between 2011 and 2020, although it declined in 2021: the poverty rate was 22% in 2011 and estimated to be 41% in 2021. Although poverty remains an overwhelmingly rural phenomenon, it has increased relatively faster in urban areas, leading to the urbanisation of poverty. Nevertheless, agricultural activity remains a major source of income and food for many families, particularly in rural areas, and has helped in creating better standards of living while reducing rural to urban migration.

Agriculture is the foundation of Zimbabwe's economic growth. According to World Bank Development Indicators (The World Bank Group 2022a), Zimbabwe's agriculture, forestry, and fishing value added as percentage of gross domestic product (GDP) was around 8.5% on average for the past decade. Although agriculture, forestry and fishing value added (% of GDP) has been declining over time, there is highly productive arable land in Zimbabwe which gives the nation an opportunity to stimulate growth through agriculture production. Given that these resources are continuously utilised efficiently to expand agricultural output, this may have a significant impact on economic growth. The economy rebound that happened in 2021 was driven by recovery of agriculture and industry. GDP is estimated to have grown by 5.8% in 2021 after contracting by 6.2% in 2020 (The World Bank Group 2022b). An exceptionally good agriculture season coupled with slowing inflation and higher remittances boosted domestic demand. However, over the past decade, several severe droughts and cyclones, such as the recent Cyclone Idai, which have occurred in Zimbabwe have contributed to the reduction in agricultural production as well as low economic growth, leading to high poverty and food insecurity. With the climate change effect, enhancing labour-intensive agriculture smart goods production can be crucial for a quicker economic recovery, employment creation and poverty alleviation.

The abundance of natural and human resources needed for agriculture in Zimbabwe raises debate on whether labour-intensive agriculture production should be used as an instrument for growth. To the best of our knowledge there is scant research about the impact of agriculture production on the economic growth of Zimbabwe. The main objective of this paper is to develop an econometric model, analysing the impact of agriculture production on economic growth. The research problem is to evaluate if agriculture production creates sustainable growth in Zimbabwe.

The limited studies available on agriculture's role in Zimbabwe's economy are centred on examining the impact of agriculture expenditure on economic growth. These include the works of Mapfumo (2012), Matandare (2018), and Saungweme and Matandare (2014). In differing with these studies, we employ agricultural production as a variable of interest in assessing the role of agriculture on the economic growth of Zimbabwe. In the existing literature there is also the work of Mapfumo (2013), providing an econometric analysis of the relationship between agricultural production and economic growth in Zimbabwe. In differing with this study we employ a different econometric methodology and examine both the short-run and long-run contribution of agricultural production to Zimbabwe's economic growth using a longer time frame with the most recent data available.

The rest of this article is organised as follows: a broader overview of Zimbabwe's agricultural sector, literature review, methodology and data, econometric results, conclusion and policy implications.

Overview of Zimbabwe's Agricultural Sector

After the country obtained its independence in 1980, various agricultural policies were implemented, including land reform programmes and support of local farmers with advice, inputs and funding to improve agricultural production. Zimbabwe inherited a heavily government-backed agricultural sector from the Smith Administration (Saungweme and Matandare 2014). Land reform programmes started in 1980 as an effort to achieve a more equitable distribution of land, although many have criticised the 2000 land reform programme as having failed to end hunger and having increased malnutrition. Gumede (2018) shows that before the land reform, the country was agriculturally almost self-sufficient, but land reform collapsed agricultural productivity to such an extent that the country ended up importing most products.

The land reform of Zimbabwe focused exclusively on taking successful commercial farms. As a result, agricultural productivity was affected. Zimbabwe's exports income was reduced, and food production was also disrupted as productivity plummeted. Contrary to this, Thomas (2003) argued that it is difficult to say the land reform programmes alleviated Zimbabwe's economic crisis because, as the country was pursuing its recovery by stimulating agricultural potential through land reforms, the approach exposed the country to international threats and sanctions. On the other hand, Gonese et al. (2002) also highlighted that the land reform programme was subsequently beset with major challenges arising from heightened demand for land at a time of its marked unavailability on the market and from grossly inadequate funding to enhance agricultural productivity. According to the International Trade Administration (2022), following the government's fast-track land reform programme which began in 2000, irrigation infrastructure deteriorated, and most of the new landowners depend on rain rather than irrigation for their crops. As the weather pattern changes and droughts become more frequent, the country has failed to produce enough grain to meet domestic demand.

The government also subsidised the agriculture sector to promote and empower both small- and large-scale farmers. The International Trade Administration (2022) states that during the 2020/2021 agricultural season, the government allowed the private sector to fund agricultural activities, which improved transparency in the sector. The government has taken steps to promote cultivation of sorghum and millet, which are more ecologically compatible with Zimbabwe's semi-arid areas. Irrigation systems have been installed and, recently, smart agriculture is being adopted to ensure green, inclusive and sustainable development. The Food and Agriculture Organization (2022) mentions that agriculture is the backbone of Zimbabwe's economy since the population remains largely rural and people derive their livelihood from agriculture and other related rural economic activities. Rates of poverty are higher in rural areas than in urban areas. Therefore, to ensure shared prosperity, there is a need to support agricultural production, be it on a subsistence or commercial level. FAO (2022) shows that agricultural activities in Zimbabwe provide employment and income to 60–70% of the population, supply 60% of the raw materials required by the industrial sector, and contribute 40% of total export earnings.

Zimbabwe is a landlocked country with a total land area of over 39 million hectares, with 33.3 million hectares used for agricultural purposes (FAO 2022). There are about 6 million hectares that have been reserved for national parks and wildlife, and urban settlements. The country comprises four physio-geographic regions, which are the Eastern Highlands, the Highveld, the Middle veld, and the Low veld. The World Bank (The World Bank Group 2022b) states that the population is over 15 million and this information shows that land and labour are in abundance, and these are key resources needed in farming. These resources are adequate to expand agricultural production and strengthen comparative advantages over other countries.

FAO (2022) shows that agriculture contributes approximately 17% to Zimbabwe's GDP. As the main source of livelihood for most of the population, the performance of the agriculture sector is paramount for rural livelihood resilience and poverty levels. There are, however, challenges facing smallholder farmers including low and erratic rainfall, low and declining soil fertility, low investment, shortages of farm power – labour and draft animals, poor physical and institutional infrastructure, poverty, and recurring food insecurity. According to the World Food Programme (World Food Programme 2022), Zimbabwe was added to the list of FAO-WFP Hunger Hotspots in May 2022 due to an erratic rainfall season and consequent drop in expected crop production (which declined by 43% as compared to the previous year; farmers' yields shrunk by half).

The Zimbabwe agricultural sector still has challenges of gender inequality in terms of access to resources such as land. However, although men are still dominating the agriculture sector, women are increasingly getting involved. Traditionally, families believed in having bigger family sizes to assist with farming, and the bigger the family size the more the output and income. In this setup men were responsible for farming and hunting while women were responsible for the house and taking care of children. This disadvantaged the women as land ownership is skewed to the men. The majority of these farmers were farming for subsistence and barter trade. However, the current agricultural sector is composed of large-scale commercial farming and small-scale farmers, with the latter occupying more land area but located in regions where land is relatively infertile with more unreliable rainfall and poor or no irrigation systems.

Agriculture in Zimbabwe involves crop production, animal production, forestry, and fishing. Most rural homes have a separate piece of land where they can farm on a small scale or large scale. Their farm products include maize, tobacco, groundnuts, cotton, sheep, goats, and cows. Their produce is used either for family consumption, domestic trade, or exporting. The main agricultural export is tobacco, which is exported to countries like the Democratic Republic of Congo, South Africa, Botswana, China, Zambia, the Netherlands, and the United Kingdom.

Livestock keeping has also contributed significantly to the economy of Zimbabwe, with cattle accounting for 35% to 38% of the GDP contributed by the agricultural sector (FAO 2022). Most families in the rural areas of Zimbabwe either keep donkeys, cattle, sheep, goats, or chickens. FAO (2022) estimated that up to 60% of rural households own cattle and 70–90% own goats, while over 80% own chickens. The importance of livestock in rural livelihoods and food security lies in the provision of meat, milk, eggs, hides and skins, draught power, and manure. Livestock in Zimbabwe also acts as a strategic household investment. Small ruminants (sheep and goats) and non-ruminants, particularly poultry, are an important safety net in the event of drought – they are easily disposable for cash when the need arises. Zimbabwe's smallholder system has the potential to grow and become the mainstream of the livestock sector's performance indicator.

Forests cover 40% of Zimbabwe's total area, accounting for 15,624,000 hectares (The World Bank Group 2022b). However, according to FAO (2022), Zimbabwe has had a steady deforestation rate in the last twenty years. Deforestation is a result of poor access to energy in rural areas and a production capacity not able to meet increasing energy demand in urban areas. The deforestation rate averages 327,000 hectares lost annually since 1990, or more than 6 million hectares of forests lost in the last 2 decades (FAO 2022).

Agriculture production has not been having good returns due to various factors leading to food shortages. World Food Programme (2022) classified Zimbabwe as a lower-middle income and food-deficit country which over the last decade has experienced several economic and environmental shocks that have contributed to high food insecurity and malnutrition. At least 49% of its population live in extreme poverty- many impacted by the effects of climate change, protracted economic instability and global stressors.

As a tropical country, Zimbabwe generally experiences a dry savannah climate with high temperatures in most parts of the year. Maiyaki (2010)

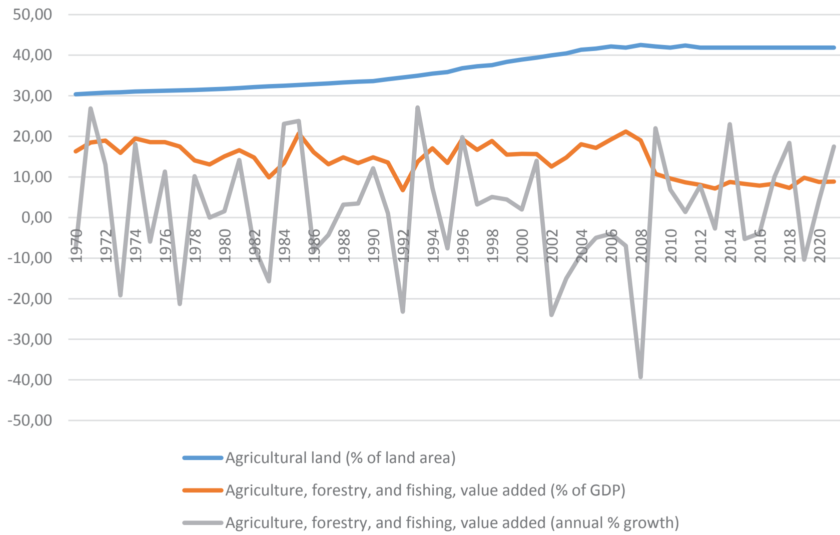

FIGURE 1 Agriculture Performance in Zimbabwe (authors' elaboration of World Bank (2022b) data)

shows that Zimbabwe's climate is dependent on the rains brought by the Indian Ocean monsoons (seasonal winds). The Eastern part of the country has up to 1,000 mm of rainfall each year between the months of October and March. However, rain levels reduce to about half that amount in the dry southwest. Between March and October, there is very little, if any, rainfall and this is when the weather gets cold, with frosts common in the mountains and central plateau areas. Since the late 1970s, rainfall has been very irregular and there have been serious droughts and cyclones which have led to soil erosion in some areas and decreased agricultural production (Mapfumo 2013).

With its fertile land, Zimbabwe used not only to be self-sufficient but also to produce surplus agricultural goods for exporting to other neighbouring countries. However, the situation has changed in recent years to the extent that the country can no longer feed itself and depends on foreign aids and loans. Due to the previous economic and political issues and climate change, the Zimbabwean agricultural system has become weaker. As a landlocked country with over 63% of people living below the poverty line, the use of land for agricultural purposes has been increasing sharply since 2000 (World Food Programme 2022), as shown in figure 1.

The percentage of land used for agriculture has been increasing in past years although the country's agricultural productivity has been low due to

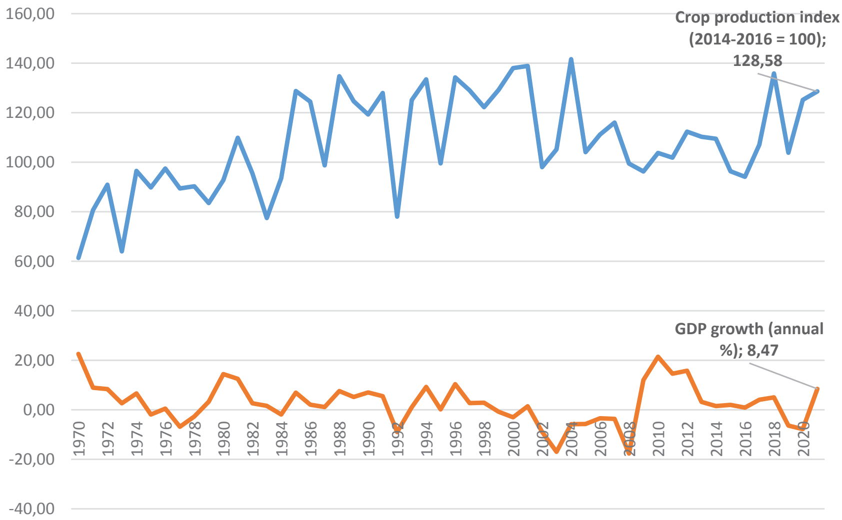

FIGURE 2 Crop Production Index versus GDP Growth (authors' elaboration of World Bank (2022b) data)

many factors such as widespread poverty, the outbreak of diseases such as HIV/AIDS, limited employment opportunities, liquidity challenges, recurring climate-induced shocks and economic instability. Despite increasing agriculture land use in Zimbabwe, agriculture contribution to its GDP has recorded a declining trend since 1985. Although agriculture, forestry and fishing value added as a percentage of GDP has recorded some recoveries over certain periods, this has not been the case after 2007 as agricultural contribution has been on the decline. Agriculture's annual percentage growth has been swinging between −39% and 27%.

Zimbabwe is characterised by lots of arable lands, with some parts of the country having good rainfall patterns, and there is lots of labour in the country. These are key factors of production that are required to boost agriculture. The World Food Programme (2022) shows that about 70% of the population is dependent on rain-fed farming, while most farmers are smallholders with low productivity. Due to several challenges, including economic crisis and lack of markets, agriculture in the country has been wobbly between 1970 and 2022, and eventually started decreasing between 2012 and 2020, as shown in figure 2. The decline in agricultural production could also be associated with global disasters such as climate change as famers are still adjusting to this and others are struggling with financing climate change activities.

Literature Review

SOLOW MODEL

Agriculture production affects economic growth through various channels. Various theoretical frameworks can be linked to the relationship between agriculture production and economic growth. For brevity purposes, we link this study to the Solow model. According to Hoeffler (2002), in the Solow model, growth in output depends on initial output per worker, y (0), the initial level of technology, A (0), the rate of technological progress, g, the savings rate, s, the growth rate of the workforce, n, the depreciation rate, δ, the share of capital in output, α, and the rate of convergence to the steady state, λ. Hoeffler (2002) further explained that the model predicts that a high savings rate will affect growth in output per worker positively whereas high labour force growth (corrected by the rate of technological progress and rate of depreciation) will have a negative effect on growth in output per worker. As given by Hoeffler (2002) the Solow basic model is stated as:

$$\begin{aligned}\ln y_t - \ln y_0 = {} & -1(1-e^{-\lambda})\ln y_0 + (1-e^{-\lambda})\ln A_0 \\ & + gt + (1-e^{-\lambda})\frac{\alpha}{1-\alpha}\ln s \\ & - (1-e^{-\lambda})\frac{\alpha}{1-\alpha}\ln(n+g+\sigma),\end{aligned} \tag{1}$$

where y_t denotes the logarithm of output per worker in period t.

The above Solow growth model relates to this study through two channels. As articulated by Safdar, Maqsood, and Ullah (2012), high agriculture production volatility means more income risk, which tends to raise precautionary savings, which in turn encourages investment in the agriculture sector and helps in boosting economic growth. As given by the Solow model, a high savings rate will affect growth in output per worker positively, which in turn increases productivity. In contrast, a high agriculture production volatility may also mean more investment risk in the agriculture sector, which tends to discourage investment in the agriculture sector and thereby slowing down economic growth.

In the Cobb-Douglas production function based on constant returns to scale as given by

$$Y = K^a L^{1-a}, \tag{2}$$

where Y is output level produced for a given employment levels of inputs capital (K) and labour (L). The relationship between inputs and outputs is positive. This relates to this study as labour force participation in the agriculture sector is also important in determining agriculture performance, thereby causing increases in agricultural production and thus the GDP of Zimbabwe.

THE EMPIRICAL LITERATURE ON AGRICULTURE AND ECONOMIC GROWTH

To date, there is well-documented research to probe the impact of agricultural production on growth for several developing countries. Many studies adopt the Solow-Swan neoclassical growth theory to analyse the impact of agriculture on growth. On the standard Solow-Swan growth equation, agriculture is added as an engine for growth, and this is used to measure the linkages between the rural and industrial sectors of the economy (Hwa 1983).

The Literature on Developed Countries

Most developed countries do not necessarily specialise in agricultural production because of limited agricultural resources and because their weather conditions are not conducive for farming and livestock rearing. Developed countries are capital abundant and produce capital-intensive goods. The Heckscher-Ohlin theory states that countries with lots of labour produce labour-intensive goods while capital-abundant countries produce capital-intensive goods (Markusen 2005). Although machinery is increasingly getting used in agriculture, lots of labour remains the main factor.

There is a handful of research focusing on the relationship between agriculture production and growth in developed economies and this includes the works of Katircioglu (2006), Yao (2000), and Xuezhen, Shilei, and Feng (2010). Katircioglu (2006) employed the Granger causality to show a bi-directional relationship between agriculture production and growth in North Cyprus. Yao (2000) shows that although agriculture's share in GDP declined sharply over time in China, it is still an important force for the growth of other sectors, resulting in an overall increase in China's economy. The decline in agriculture's share in GDP over time was as a result of China's government policies biased against agriculture to industrialise the economy. Nevertheless, Yao (2000) further ascertained that without agriculture providing enough food for the population, materials for industries, large capital transfers to state revenue and foreign exchange, the entire economy can suffer enormously. Xuezhen, Shilei, and Feng (2010) concur that although the share of agriculture in GDP has declined significantly over time in China, the contribution of agricultural growth has maintained an upward trend and it has made important market, foreign exchange, factor (finance and labour), and output contributions to non-agricultural growth and thus it remains an irreplaceable driving force for economic growth in China.

The Literature on Developing Countries

The effect of agriculture on economic growth in developing countries has yielded more debate. Most developing countries, particularly African nations, have a comparative advantage in producing labour-intensive agricultural goods. There is a bountiful amount of research focusing on establishing the impact of agriculture on economic growth in developing economies. These studies include the works of Ansari, Rashid, and Alam (2022), Agboola et al. (2022), Uddin, Rahman, and Majumder (2022), Oyinbo and Rekwot (2014), Jatuporn et al. (2011), Awokuse and Xie (2015), Odetola and Etumnu (2013), Izuchukwu (2011), Sertoglu, Ugural, and Bekun (2017), Awan and Aslam (2015), Raza, Ali, and Mehboob (2012), Awokuse (2009), Moussa (2018) and Uddin (2015). Whether a study was investigating the impact of agriculture on growth or causal direction between agriculture production and growth, the prime conclusion for all of them was that agriculture is of paramount importance regarding the economic growth of these developing countries. Jatuporn et al. (2011) show the existence of a long-term stable bi-directional relationship running from agriculture to economic growth and from economic growth to agriculture in Thailand. Moussa (2018) reveals that GDP per capita, agricultural value added, and the human development index have a long-run relationship in the case of Benin. Adding to that, an expansion of the agricultural sector will have a significant impact on the economy in the long run and ameliorate the living conditions of the population. Awan and Aslam (2015) concluded that the economic growth of Pakistan can be increased due to a positive trend in agriculture value added. A recent study by Ansari, Rashid, and Alam (2022) shows that while the production of wheat, rice, and tobacco has a positive impact on India's GDP development, the production of pulses and sugarcane has an inverse, but not insignificant, impact. Uddin, Rahman, and Majumder (2022) also reveal that agriculture has a positive impact on Bangladesh's GDP in the long run and short run.

The effect of agriculture production on the economic growth of Nigeria has also been widely researched. Literature based on Nigeria only includes the works of Agboola et al. (2022), Oyinbo and Rekwot (2014), Odetola and Etumnu (2013), Izuchukwu (2011), and Sertoglu, Ugural, and Bekun (2017). One thing that these studies are congruent about is that agriculture has a significant positive effect towards the Nigerian economic growth. The works of Agboola et al. (2022) concluded that the effect of forestry, crop production and fishery on Nigeria's economic growth is statistically significant and positive. However, Odetola and Etumnu (2013) show that although agriculture contributes to growth, growth itself does not increase agriculture, indicating no reverse causality. On the other hand, Izuchukwu (2011) took a different turn and reveals that there is a positive relationship between Gross Domestic Product (GDP), and the Government Expenditure on Agriculture and Foreign Direct Investment on Agriculture.

In assessing this relationship, various estimation techniques were employed. The ARDL helps in distinguishing between the short-run and long-run effects influencing a relationship and the Granger causality test has the ability to examine many lags, with higher-order lags discounted. The works of Oyinbo and Rekwot (2014), Jatuporn et al. (2011), Awokuse and Xie (2015), Odetola and Etumnu (2013), Awan and Aslam (2015), and Awokuse (2009) employed the ARDL cointegration technique and the Granger causality test to test for the directional effect. Sertoglu, Ugural, and Bekun (2017) and Moussa (2018) employed the Johansen test and the Vector Error Correction Model (VECM). On the other hand, Raza, Ali, and Mehboob (2012) employed the Ordinary Least Squares (OLS) method while Izuchukwu (2011) employed the SPSS technique.

The Literature on Zimbabwe's Case

Due to the insubstantial availability of studies focusing on the agriculture-growth nexus in Zimbabwe, five studies were reviewed. This section includes the works of Mapfumo (2012; 2013), Bautista and Thomas (1999), Saungweme and Matandare (2014), and Matandare (2018). The studies by Mapfumo (2013) and Matandare (2018) employed the Johansen test while Mapfumo (2012) and Saungweme and Matandare (2014) employed the OLS estimation technique. Bautista and Thomas (1999) employed the Social Accounting Matrix (SAM) in determining the impact of agricultural production on Zimbabwe's economic growth. Despite the different estimation techniques employed, all these studies come to the same conclusion that agriculture is vital for the economic growth of Zimbabwe.

Matandare (2018) shows that agriculture has a long-run impact on Zimbabwe's growth, while Mapfumo (2012) suggests that spending more on agricultural research and development can improve economic growth and ultimately reduce poverty.

Furthermore, empirical analysis by Mapfumo (2013) provides strong evidence indicating that agricultural production is important in improving the wellbeing of countries, especially in Zimbabwe. The results from Mapfumo (2013) suggest that the value of agricultural production of tobacco, maize and cotton positively affected economic growth in Zimbabwe from 1980 to 2010. Saungweme and Matandare (2014) indicate that increased agriculture expenditure before 2000 has boosted production in the sector and strengthened forward and backward economic linkages. However, the land reform programme of 2000 and subsequent reduction in sound government support to the sector contributed immensely to the economic crises in Zimbabwe.

Methodology and Data

MODEL SPECIFICATION

The model specified is an extension of the Solow model, by including the role of agricultural production, government expenditure and inflation in influencing growth. The model used to examine the impact of agricultural production on economic growth was therefore expressed as follows:

$$\begin{aligned} \mathrm{GDP}Grwth_t &= \beta_0 + \beta_1 Infl_t + \beta_2 Agric_t + \beta_3 \mathrm{GFCF}_t \\ &\quad + \beta_4 GvtExp_t + \beta_5 Pop_t + \varepsilon_t, \end{aligned} \tag{3}$$

where $\mathrm{GDP}Grwth_t$ is real gross domestic product growth at time t, $Infl_t$ is inflation rate at time t, proxied by GDP deflator, $Agric_t$ is agricultural production index, GFCF_t is gross fixed capital formation as a share of GDP at time t, $GvtExp_t$ is general government expenditure as a share of GDP at time t, Pop_t is the population at time t, β_0 is the intercept, $\beta_1, \beta_2, \ldots, \beta_5$ are the slope coefficients to be estimated, and ε_t is the white noise error term. The variables were included in the model based on theory. The Solow Growth Model shows that capital, as proxied by gross fixed capital formation and labour, as proxied by population plays a pivotal role in promoting growth. While the Solow Growth Model neglected the role of land and the environment in influencing growth, the model also considers that since Zimbabwe is an agro-based economy, agricultural production plays a pivotal role in promoting growth. In addition, inflation is one of the macroeconomic problems the economy is facing, with monetarist theory showing that money supply has influence on output in the short run and on inflation in the long run.

The Keynesian theory also shows that high government expenditure plays a pivotal role in stimulating aggregate demand and promoting growth, thus justifying the inclusion of inflation and government expenditure as variables in the model.

STATIONARITY TEST

The unit root test/stationarity test was done using the Augmented Dickey-Fuller (ADF) unit root test to determine the order of integration of the variables, and the ADF is specified as follows:

$$y_t = \mu + \beta_t + \gamma_0 y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \varepsilon_t, \tag{4}$$

where y_t is the variable under consideration, $\mu, \beta, \gamma_0, \gamma_i$ are parameters of the model, ε_t is the white noise error term, and y_{t-i} denotes lag differences of the variable under consideration with lag p. The ADF test is an extension of the Dickey-Fuller test, for it accommodates some form of serial correlation (Greene 2003). If γ_0 is statistically significant, then the series is stationary, otherwise, the series must be differenced d times to be stationary.

AUTOREGRESSIVE DISTRIBUTED LAG (ARDL) COINTEGRATION

In order to analyse the impact of agricultural production on economic growth, the study used the Autoregressive Distributed Lag (ARDL) model by Pesaran and Shin (1998) and Pesaran, Shin, and Smith (2001). The ARDL approach is preferred over other traditional cointegration models such as the Engle-Granger cointegration test and the Johansen and Juselius cointegration test, since these apply to series that are integrated of the same order I(d) only. The ARDL model can be applied to series that are integrated of order one I(1), order zero I(0), or mutually cointegrated. Thus, the ARDL model is appropriate regardless of the integration of the variables, whether they are stationary in levels I(0) or after first difference I(1) or both of mixed order of integration. The ARDL model also takes small sample size and simultaneity biases in the relationship between the variables in the model. The ARDL approach to cointegration was specified as follows:

$$\begin{aligned}\Delta \text{GDP}Grwth_t = \beta_0 &+ \sum_{i=0}^{p} \beta_1 \Delta \text{GDP}Grwth_{t-1} + \sum_{i=0}^{q} \beta_2 \Delta Infl_{t-1} \\ &+ \sum_{i=0}^{r} \beta_3 \Delta Agric_{t-1} + \sum_{i=0}^{s} \beta_4 \Delta \text{GFCF}_{t-1} \\ &+ \sum_{i=0}^{t} \beta_5 \Delta GvtExp_{t-1} + \sum_{i=0}^{u} \beta_6 \Delta Pop_{t-1} \\ &+ \alpha_1 \text{GDP}Grwth_{t-1} + \alpha_2 Infl_{t-1} + \alpha_3 Agric_{t-1} \\ &+ \alpha_4 \text{GFCF}_{t-1} + \alpha_5 GvtExp_{t-1} + \alpha_6 Pop_{t-1} + \varepsilon_t, \qquad (5)\end{aligned}$$

where β_0 is the intercept, $\beta_1, \beta_2, \ldots, \beta_6$ represent the short-run dynamic coefficients of the variables, while $\alpha_1, \alpha_2, \ldots, \alpha_6$ represent the long-run coefficients, and $p, q, r, s, t, u$are the lag length which is determined automatically using the Akaike Information Criterion (AIC). Several model diagnostic tests were done. The F-test was used to test the existence of a long-run relationship between the variables in the model. The null hypothesis that there is no cointegration was stated as follows:

$$\text{H}_0\colon \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0. \qquad (6)$$

The alternative hypothesis that there is cointegration between the series was specified as follows:

$$\text{H}_1\colon \alpha_1 \neq 0, \alpha_2 \neq 0, \alpha_3 \neq 0, \alpha_4 \neq 0, \alpha_5 \neq 0, \alpha_6 \neq 0. \qquad (7)$$

If the null hypothesis is rejected, then the variables are cointegrated and the error correction model (ECM) must be estimated. The error correction model is used to show the speed of adjustment towards the long-run equilibrium and was expressed as follows:

$$\begin{aligned}\Delta \text{GDP}Grwth_t = \beta_0 &+ \sum_{i=0}^{p} \beta_1 \Delta \text{GDP}Grwth_{t-1} + \sum_{i=0}^{q} \beta_2 \Delta Infl_{t-1} \\ &+ \sum_{i=0}^{r} \beta_3 \Delta Agric_{t-1} + \sum_{i=0}^{s} \beta_4 \Delta \text{GFCF}_{t-1} \\ &+ \sum_{i=0}^{t} \beta_5 \Delta GvtExp_{t-1} + \sum_{i=0}^{u} \beta_6 \Delta Pop_{t-1} \\ &+ \lambda \text{ECM}_{t-1} + \varepsilon_t, \qquad (8)\end{aligned}$$

where ECM_{t-1} is the error correction term, and λ is the parameter indicating speed of adjustment towards the long run equilibrium. The serial correlation test was done using the Breusch-Godfrey LM test while the Breusch-Godfrey-Pagan test was used to test for heteroscedasticity. The test for normality of residuals was done using the Jarque-Bera test while the Cumulative Sum of Squares (CUSUMSQ) was used to test for model parameter stability. The Ramsey Regression Specification Error Test (RESET) was used to test for model misspecification.

DATA SOURCES AND DESCRIPTIVE STATISTICS

Data Sources

The study used annual data for the period 1970 to 2019 from the World Development Indicators (WDI). The study used this particular period because of data availability on all the variables in the study, and the period is long enough to perform regression analysis. The variables are described in table 1.

In this study, GDP growth was used as a proxy for economic growth, GDP deflator was used as a proxy for inflation, and the agricultural production index was used as a proxy for agricultural production.

Descriptive Statistics

The summary statistics on the variables used in this study are shown in table 2. The summary shows that GDP growth, gross fixed capital formation as a share of GDP, and government expenditure as a share of GDP have been relatively stable over the study period compared to agricultural production, inflation and population as shown by low standard deviation. The maximum values of GDP growth, agricultural production, gross fixed capital formation as a share of GDP, inflation, and government expenditure as a share of GDP show that the Zimbabwean economy at some point recorded high growth, high agricultural production, high

TABLE 1 Description of the Variables and their Source

Variable	Explanation	Data Source
GDP*Grwth*	Real GDP Growth	WDI
Inf	GDP Deflator	WDI
Agric	Agricultural Production Index	WDI
GFCF	Gross Fixed Capital Formation as a share of GDP	WDI
GvtExp	Government Expenditure as a share of GDP	WDI
Pop	Population	WDI

TABLE 2 Descriptive Statistics

Item	*Agric*	GDP*Grwth*	GFCF	*Infl*	*Pop*	*GvtExp*
Mean	97.02	2.59	14.13	3.75	10399590	16.79
Median	94.93	2.24	14.77	2.63	11336229	17.91
Maximum	125.71	22.57	24.58	95.41	14645468	27.49
Minimum	55.45	−17.67	2.00	−27.05	5289303	2.05
Std. Dev.	17.73	8.14	5.65	15.91	2732645	5.11
Skewness	−0.24	−0.03	−0.43	3.67	−0.417235	−0.80
Kurtosis	2.31	3.49	2.63	23.46	1.951	4.10
Jarque-Bera	1.45	0.52	1.82	984.89	3.743209	7.81
Probability	0.48	0.77	0.40	0.00	0.153877	0.02
Observations	50	50	50	50	50	50

gross fixed capital formation as a share of GDP, high inflation, and high government expenditure as a share of GDP over the study period.

The minimum values of GDP growth, agricultural production, gross fixed capital formation as a share of GDP, inflation, and government expenditure as a share of GDP show that the Zimbabwean economy at some point recorded poor growth, poor agricultural production, poor gross fixed capital formation as a share of GDP, deflation, and low government expenditure as a share of GDP over the study period. The variables used in the study are negatively skewed and normality distributed as shown by kurtosis, the Jarque-Bera statistic and its probability value, except for inflation, which are positively skewed and not normally distributed. However, the skewness and normality of the variables does not affect the results of the study.

Econometric Results

The ADF unit root test was done, and the results show that all the variables were non-stationary in levels except agricultural production index, inflation, and GDP growth. Thus, gross fixed capital formation as a share of GDP, government expenditure as a share of GDP, and population were found to be non-stationary in levels while inflation, GDP growth, and agricultural production index were found to be stationary in levels I(0). The ADF unit root test results are shown in table 3.

The series that were non-stationary in levels were differenced once and became stationary. Thus, gross fixed capital formation as a share of GDP,

TABLE 3 Augmented Dickey-Fuller Unit Root Test Results

	Variable	ADF test statistic	Critical value at			Decision
			1%	5%	10%	
(a)	GDP*Grwth*	−4.64613	−3.57131	−2.92245	−2.59922	Stationary I(0)
	Infl	−6.18359	−3.57131	−2.92245	−2.59922	Stationary I(0)
	Agric	−4.74446	−3.57131	−2.92245	−2.59922	Stationary I(0)
	GFCF	−2.57766	−3.57131	−2.92245	−2.59922	Non-stationary
	GvtExp	−2.89507	−3.57131	−2.92245	−2.59922	Non-stationary
	Pop	−1.63015	−3.58474	−2.92814	−2.60222	Non-stationary
(b)	D(GFCF)	−8.68921	−3.57445	−2.92378	−2.59992	Stationary I(1)
	D(*GvtExp*)	−7.40431	−3.57445	−2.92378	−2.59992	Stationary I(1)
	D(*Pop*)	−3.82828	−4.21913	−3.53308	−3.19831	Stationary I(1)

NOTES Row headings are as follows: (a) ADF Unit root test results in levels, (b) ADF Unit root test results after first difference.

TABLE 4 ARDL Bounds Test Results Using Narayan (2005) Critical Values

Significance	Lower Bound	Upper Bound
10%	2.435	3.6
5%	2.900	4.218
1%	3.955	5.583

NOTES *F*-statistic = 7.6116 (significant at 10% level). Critical values are obtained from Narayan (2005), Table Case III: Unrestricted intercept and no trend.

government expenditure as a share of GDP, and population were found to be integrated of order one I(1), and the results are shown in table 3.

Since some of the variables were I(0) and others were I(1), there is the possibility of a long-run relationship between the variables, and the ARDL bounds test was used to examine if the variables are cointegrated. The optimum lag length was determined using the Akaike Information Criterion (AIC) and the model with lags (3, 3, 1, 4,0, 3) was chosen. The AIC is superior to the other criteria in the case of a small sample (60 observations and below), in a manner that may minimise the chance of under estimation while maximising the chance of recovering the true lag length (Liew 2004). The ARDL bounds test results are shown in table 4.

The sample size used in this study is small, less than 100 observations, hence Narayan (2005) critical values were used. If the *F*-statistic is below the lower critical bound values, then the null hypothesis that there is no cointegration between the variables fails to be rejected. However, if the F-statistic is above the upper bound critical values, the null hypothesis is rejected and we conclude that there is cointegration among the variables. If the F-statistic falls between the lower bound critical values and the upper bound critical values, then the test is inconclusive. The ARDL bounds test shows that there is cointegration among the variables since the F-statistic (7.6116) lies above the upper bound critical value (5.583) at a 1% significance level. Since the F-statistic is statistically significant at a 1% level, there is a long-run equilibrium relationship among the variables and the short-run model, and the long-run model must be estimated.

The study results show that the variables are cointegrated and there is a long-run equilibrium relationship between the variables. The short-run and long-run model were therefore estimated.

SHORT-RUN AND ERROR CORRECTION MODEL

In table 5, the error correction model and the short-run coefficients of the ARDL model are presented. The estimated ARDL model passed all the model diagnostic tests. There was no serial correlation, residuals were normality distributed, there was no heteroscedasticity, and the model was correctly specified. The model parameters were also found to be stable. See table 6 and figure 3 for the model diagnostic test results.

The short-run results show that coefficients of GDP growth with lags one and two are positive and statistically significant at 1% and 10%, respectively. This implies that economic growth depends on the first period and the second period lagged values in the short run. Thus, an increase in the first period lagged and the second period lagged GDP growth by 1% result in an increase in economic growth by 0.58% and 0.23%, respectively, ceteris paribus. Past economic growth has an influence on future economic growth rates, and to ensure sustained economic growth, initially experiencing high economic growth is a prerequisite. The coefficient of inflation with lag zero is positive and statistically significant at a 1% level while the coefficient of inflation with lag two is negative and statistically significant at a 1% level. This shows that the current period inflation has a positive impact on economic growth, but the second period lagged inflation has a negative impact on economic growth. Thus, an increase in current inflation by 1% results in an increase in economic growth by 0.23% while an increase in the second period lagged inflation by 1% results in a decrease in economic growth by 0.24% in the short run, holding other factors constant. This shows that current inflation has a positive effect on economic

TABLE 5 Short-Run Results and the Error Correction Model

Variable	Coefficient	Std. Error	t-Statistic	Probability
D(GDP*Grwth*(−1))	0.57952***	0.19326	2.99870	0.0059
D(GDP*Grwth*(−2))	0.23474*	0.13175	1.78161	0.0865
D(*Inf*)	0.23445***	0.04884	4.80016	0.0001
D(*Inf*(−1))	−0.07594	0.06179	−1.22905	0.2301
D(*Inf*(−2))	−0.24091***	0.06040	−3.98828	0.0005
D(*Agric*)	0.19277***	0.05463	3.52849	0.0016
D(GFCF)	0.83624***	0.27974	2.98929	0.0060
D(GFCF(−1))	0.51454*	0.25405	2.02535	0.0532
D(GFCF(−2))	−0.31838	0.23999	−1.32658	0.1962
D(GFCF(−3))	−0.72994	0.24401	−2.99140	0.0060
D(*GvtExp*)	0.38788*	0.21286	1.82225	0.0799
D(*Pop*)	−0.00020	0.00023	−0.88621	0.3836
D(*Pop*(−1))	0.00102	0.00069	1.47249	0.1529
D(*Pop*(−2))	−0.00040	0.00024	−1.64793	0.1114
CointEq(−1)	−1.41584***	0.23204	−6.10180	0.0000

NOTES *, ** and *** means statistically significant at 10%, 5% and 1% level, respectively.

TABLE 6 Model Diagnostic Test Results

Test	Test statistic	Calc. value	P-value	Conclusion
Autocorrelation	F-statistic	0.20547	0.8157	There is no autocorrelation
	Obs*R-squared	0.77437	0.6790	
Normality Test	Jarque-Bera	0.27507	0.8715	Residuals normally distrib.
Ramsey RESET	F-statistic	0.00031	0.9861	Model correctly specified
	t-statistic	0.01762	0.9861	
Heteroscedasticity	F-statistic	0.67467	0.8099	No heteroscedasticity
	Obs*R-squared	15.1901	0.7104	

growth, while past inflation is harmful to economic growth. Thus, while positive inflation levels are desirable to attract investment and promote growth, high levels of inflation are harmful to future economic growth.

The coefficient of the agricultural production index was found to be positive and statistically significant at a 1% level, implying that agricultural production has a positive effect on economic growth in the short run. Thus, an increase in agricultural production by 1 unit results in an increase in economic growth by 0.19% in the short run, ceteris paribus.

This is because agricultural production plays a pivotal role in the early stages of economic development, supplying raw material to the industrial sector and promoting economic growth. The results are consistent with the results of Mapfumo (2012; 2013), Bautista and Thomas (1999), Saungweme and Matandare (2014), and Matandare (2018), among other studies. The coefficient of gross fixed capital formation as a share of GDP was found to be positive and statistically significant at a 1% level, implying that a 1% increase in the share of gross fixed capital formation in GDP results in a 0.84% increase in economic growth, holding other factors constant. The coefficient of one period lagged share of gross fixed capital formation in GDP was found to be positive and statistically significant at 10%. This implies that a 1% increase in one period lagged share of gross fixed capital formation in GDP results in an increase in economic growth by 0.51%, ceteris paribus. The coefficient of share of government expenditure in GDP was found to be positive and statistically significant at a 10% level, implying that a 1% increase in the share of government expenditure in GDP results in an increase in economic growth by 0.39% in the short run, ceteris paribus.

The error correction coefficient of −1.42 measures the speed of adjustment towards the long-run equilibrium and is statistically significant at a 1% level. The results show that the system corrects the previous period disequilibrium at a speed of 142%, and this shows that the system is overcorrecting the disequilibrium to reach the long-run equilibrium steady-state position. Thus, the long-run equilibrium is reached in less than one year and error correction terms between −1 and −2 imply that the equilibrium is achieved in a decreasing form (Narayan and Symth 2004).

LONG-RUN RESULTS

The results from the long-run model show that inflation, the share of gross fixed capital formation in GDP, population, and share of government expenditure in GDP have a positive impact on economic growth. The long-run results are shown in table 7.

The coefficient of inflation was found to be positive and statistically significant at a 1% level, implying that a 1% increase in inflation results in an increase in economic growth by 0.43% in the long run, ceteris paribus. The coefficient of share of gross fixed capital formation in GDP was found to be positive and statistically significant at a 1% level, implying that a 1% increase in the share of gross fixed capital formation in GDP results in an increase in economic growth by 1.13%, holding other things constant. The coefficient of the population was also found to be positive and statistically

TABLE 7 Long-Run Results

Variable	Coefficient	Std. Error	*t*-Statistic	Probability
Inf	0.43242***	0.10967	3.94306	0.0005
Agric	0.04364	0.05936	0.73506	0.4689
GFCF	1.13238***	0.23099	4.90233	0.0000
GvtExp	0.27396*	0.14226	1.92572	0.0651
Pop	0.00000***	0.00000	3.32687	0.0026
C	-41.01054***	8.87248	−4.62222	0.0001

NOTES *, ** and *** means statistically significant at 10%, 5% and 1% level, respectively.

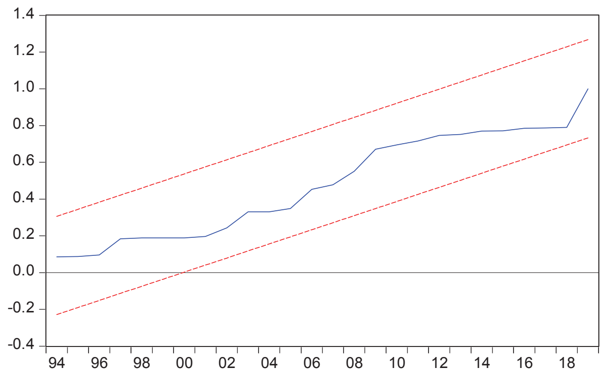

FIGURE 3 Cumulative Sum of Squared Residuals (blue – CUSUMQ, red – 5% significance)

significant at a 1% level, but the impact on economic growth was found to be small. However, the coefficient of agricultural production was found to be insignificant, implying that in the long run, economic growth is insignificantly influenced by agricultural production. This is because in the long run, when the Zimbabwean economy becomes more developed, it will not be very dependent on agriculture but will be relying much more on the industrial modern sector. In line with the theory, agricultural production plays a pivotal role in the short run, at the early stages of economic development, supplying raw material to the industrial sector, but when the economy is developed, it plays a minimal role.

Conclusion and Policy Implications

This study examined the impact of agricultural production on economic growth in Zimbabwe using data for the period 1970–2019. The ARDL bounds test was used to examine whether there is a long-run equilibrium relationship between the variables in the model. The study found that agricultural production has a positive impact on economic growth in the short run, and no impact on economic growth was found in the long run. Thus, the agricultural sector plays an important role in the early stages of economic development, and when the economy is developed, it contributes insignificantly to economic growth. The study found that inflation, the share of government expenditure in GDP, and the share of gross fixed capital formation in GDP have a positive effect on economic growth in both the short run and long run. However, the population was found to have no impact on the economy in the short run but had a positive effect in the long run.

The results imply that to promote economic growth, there is a need to ensure a sustainable inflation level, increasing government expenditure and gross fixed capital formation. The Zimbabwean economy has poor infrastructure and to promote growth, there is a need to promote gross fixed capital formation through spending on land improvements; plant, machinery, and equipment purchases; and construction of infrastructures such as roads, dams, railways, private residential dwellings, and commercial and industrial buildings, as this would attract investment in the country. The Zimbabwean economy is agro-based, and there is a need to boost agricultural production through various measures such as plugging the loopholes in the existing land legislation so that surplus land may be distributed among the small and marginal farmers, and providing adequate credit facilities at reasonable cheap rates to farmers. Fiscal incentives are required for organisations that are supporting farmers with funding, advice, inputs and other raw materials. In its budget, the Zimbabwe government should increase investment in the development of infrastructure and rehabilitation of old infrastructure used by farmers. Additionally, the government should not underestimate the value of women in agriculture. Policies are needed to empower women in agriculture and increase women's access to land and other relevant resources. With the growing effects of climate change on weather patterns, there is also a need to practice smart agriculture, especially in areas receiving poor rainfall, for the security of the crops. There is a need to identify climate smart crops and increase research on plant breeding, which considers the unique soil types of Zimbabwe, as a major requirement.

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